

Foliations and Lineations

Foliation and Lineation

- Penetrative planar/linear feature
- Product of deformation and accompanying metamorphism

In some textbooks, any penetrative planar structure (including some primary structures, such as bedding) is called a foliation.

The term S (surface) is normally used to indicate the planar features especially when overprinting relationship is shown at one outcrop.
 S_0 : bedding

Outline

- Recognizing foliations and lineations
 - Foliation ($S_i, i \geq 1$) or bedding (S_0)
 - What defines foliation/lineation
- Foliation and folds
 - Foliation bedding relationship
- Some mechanisms for development of foliations/lineations
- Recognizing Overprinting

What geological structures can you recognize here?





What geological structures can you recognize here?



Bedding or tectonic
foliation?

Can be S₀/S₁



What geological structures can you recognize here?

Early foliation/bedding was almost obliterated.



Metasedimentary rock.
Where is bedding? Where is foliation?





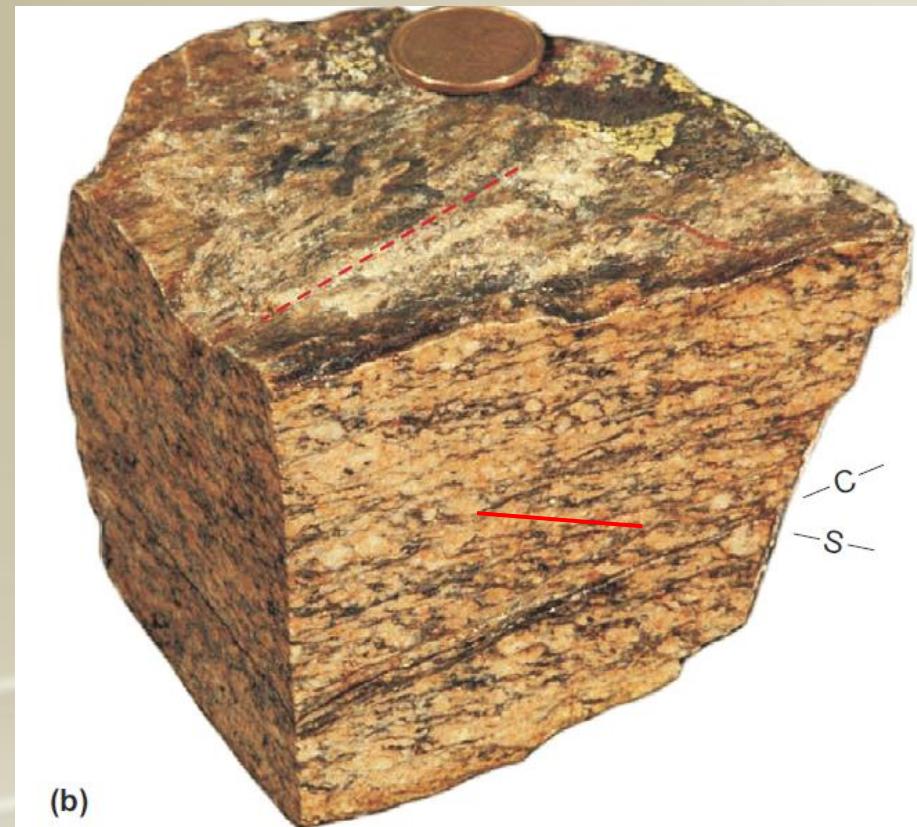
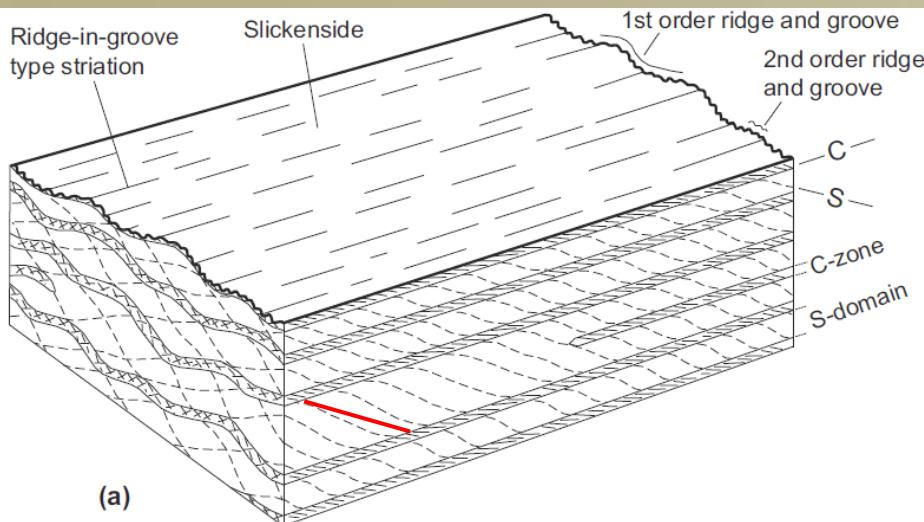






Pancake?
Cigarette?

From internet

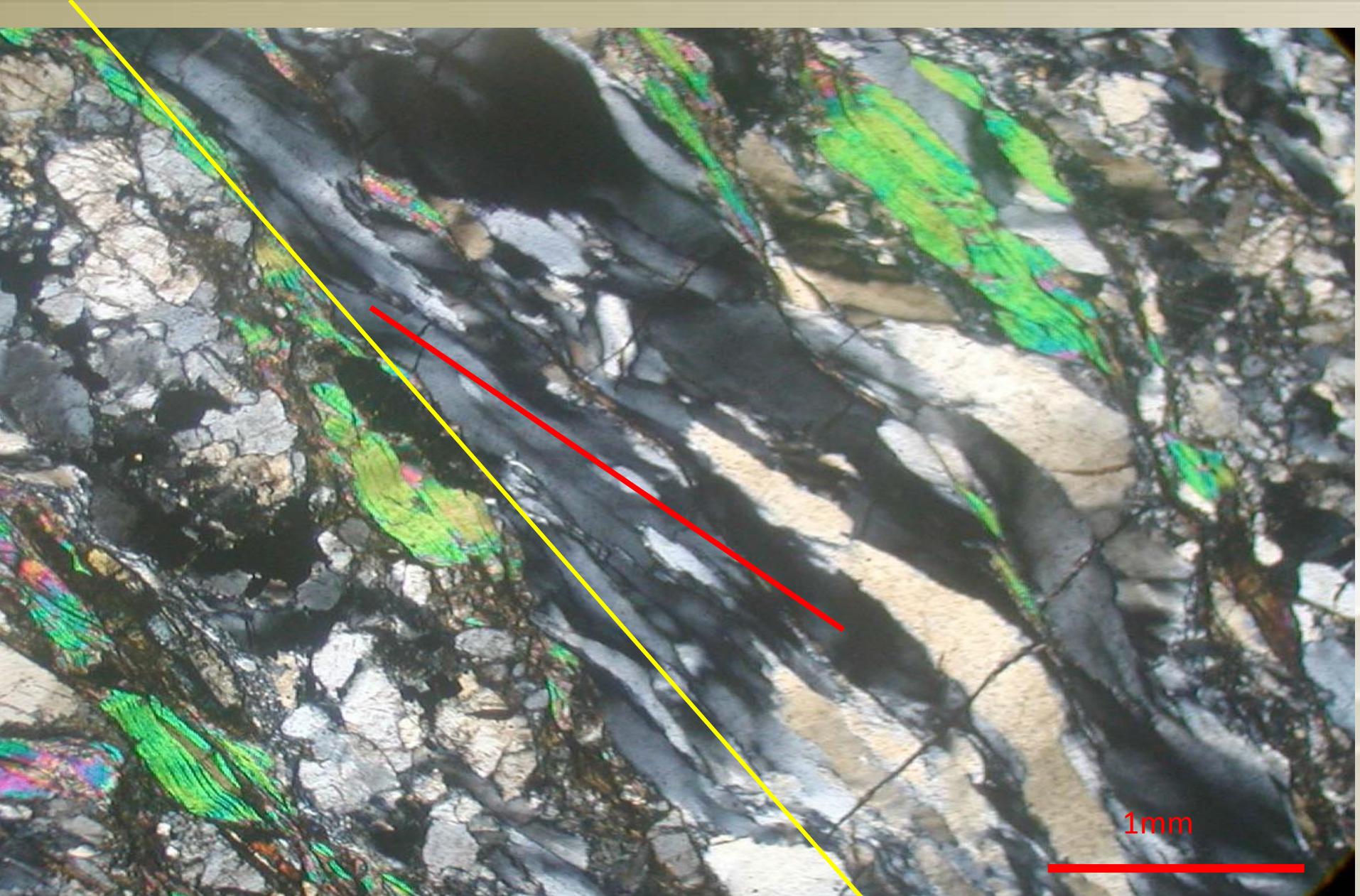


Lin et al. (2007)

S plane: A plane defined by long axis and intermediate axis of minerals

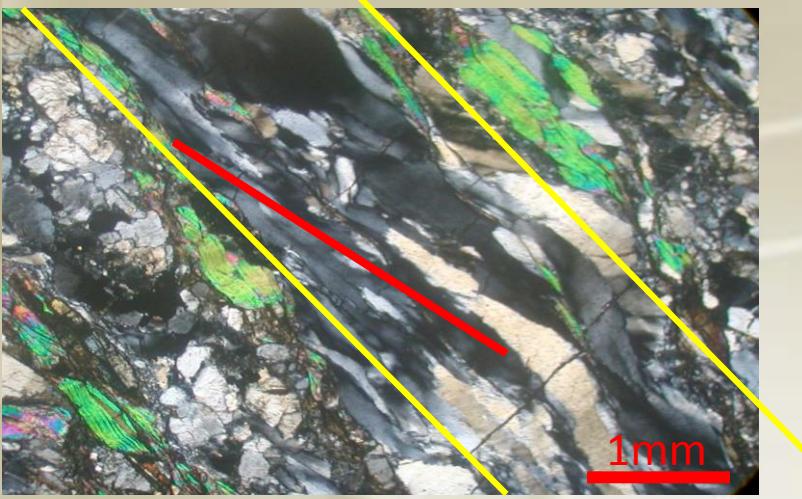
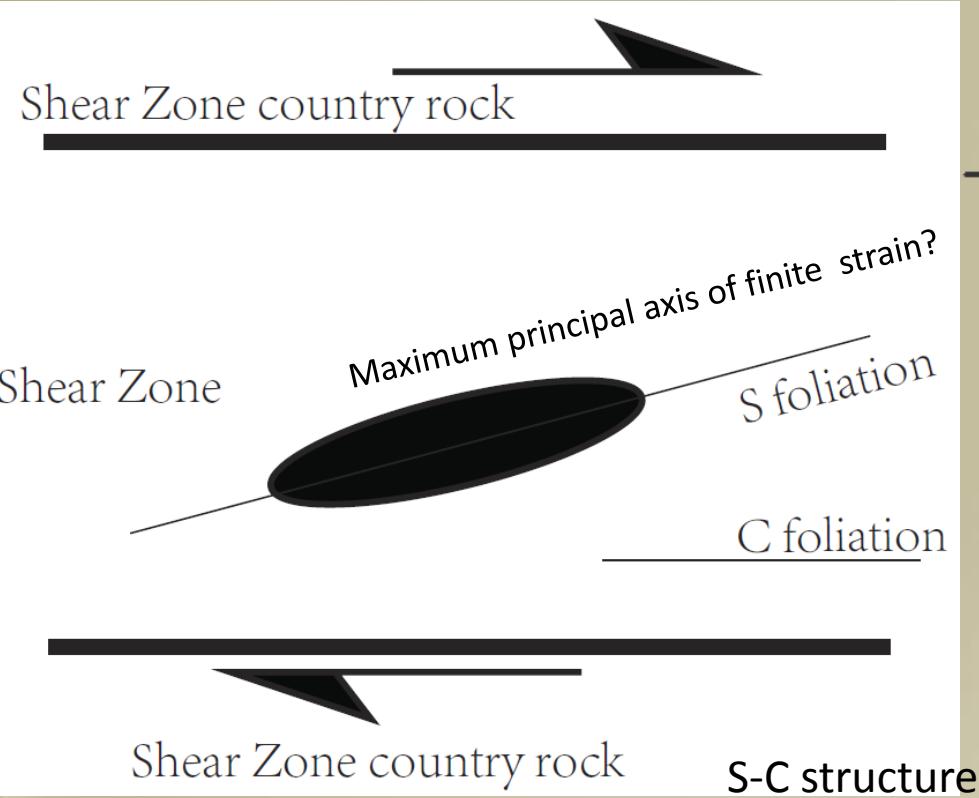
C plane: micro-scale strain localized tabular zone; Mica normally along

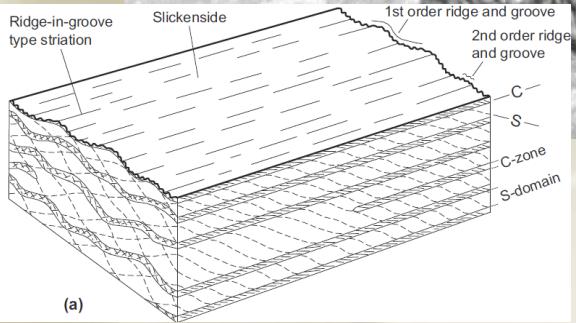
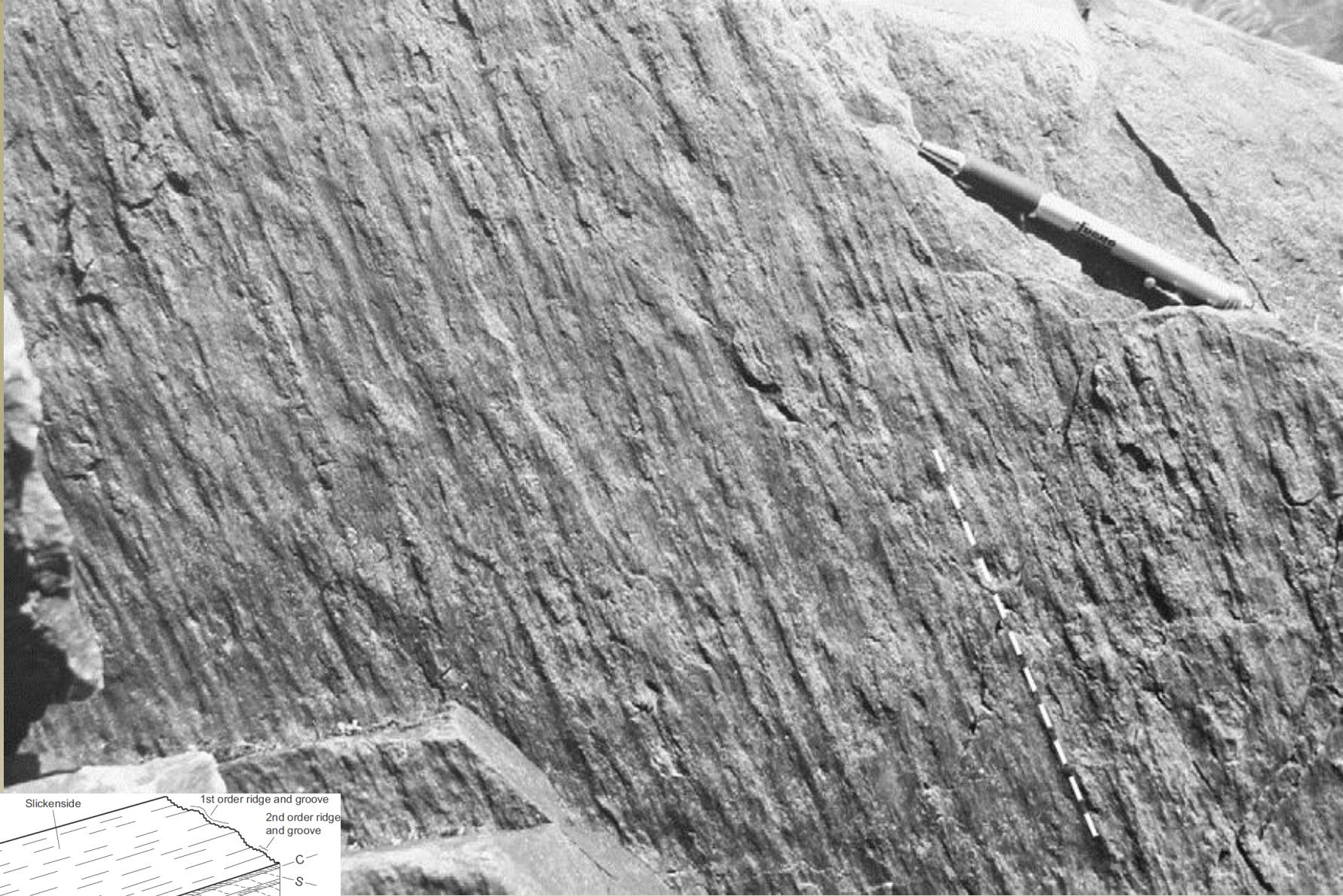
Granitic Mylonite



Shape (s) foliation; mineral lineation

C foliation (C comes from the French word “cisaillement”, and it means “shear”)





Lin et al. (2007)

Slickenside striation on C foliation



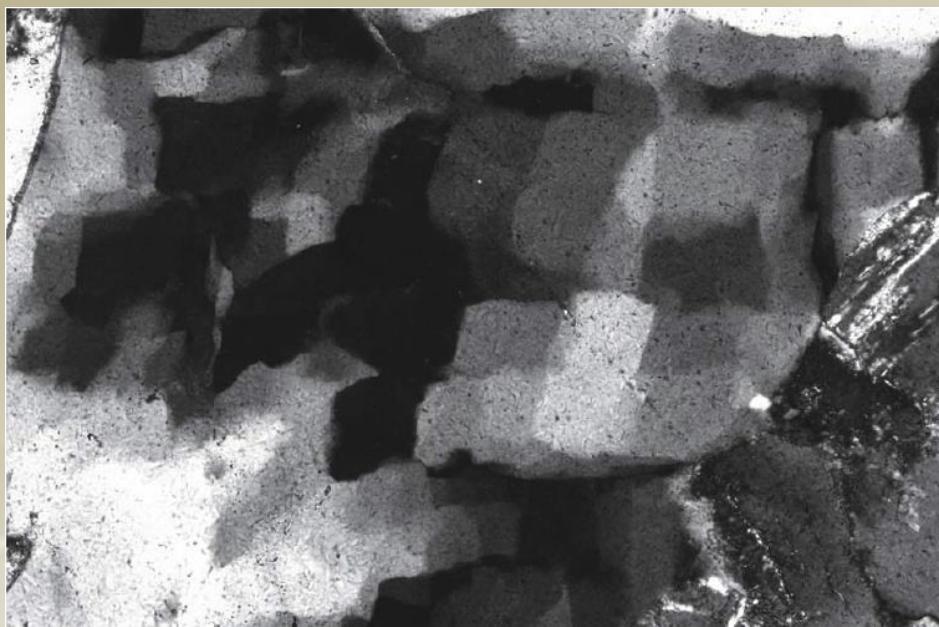
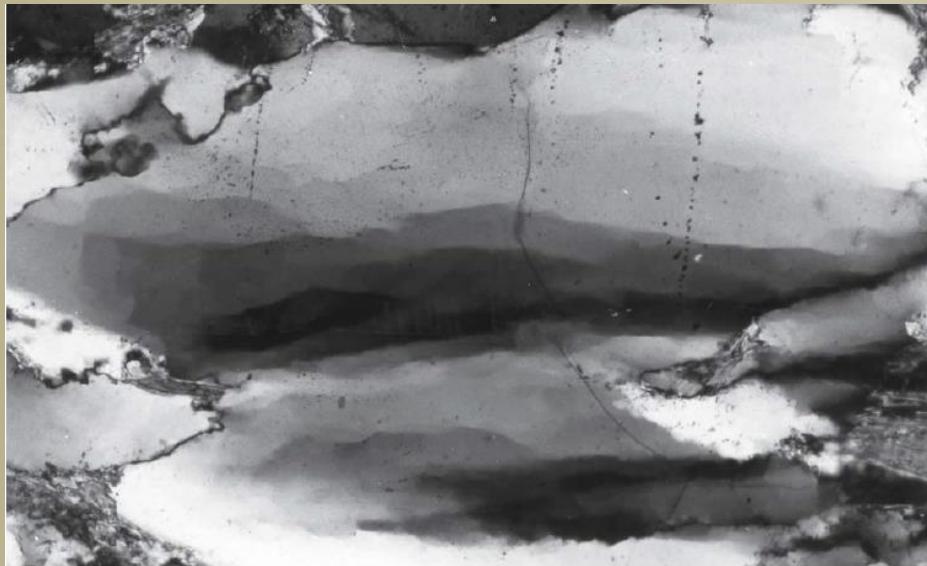
Passchier and Trouw (2006)

Undulose extinction



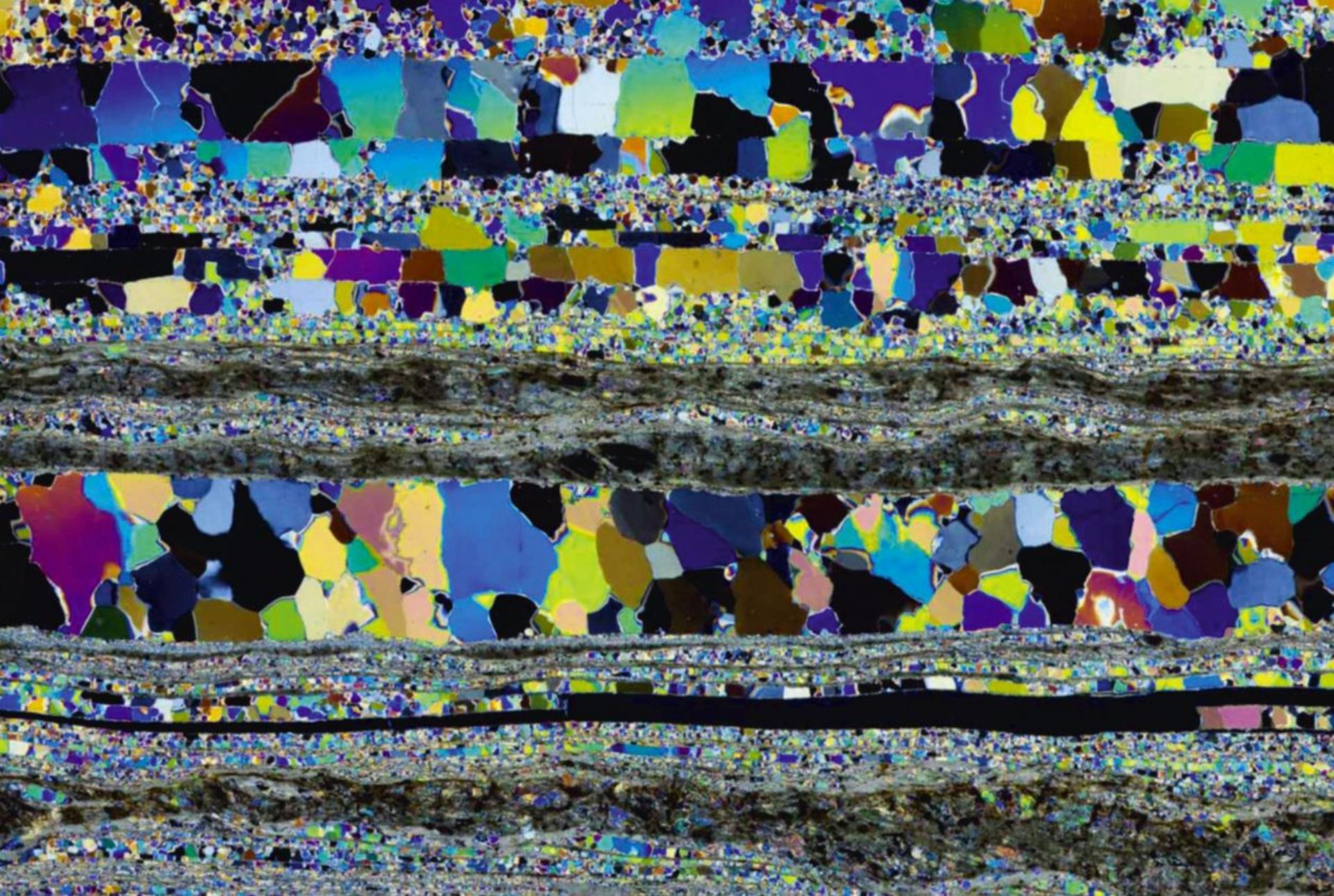
Undulose extinction

From internet



Passchier and Trouw (2006)

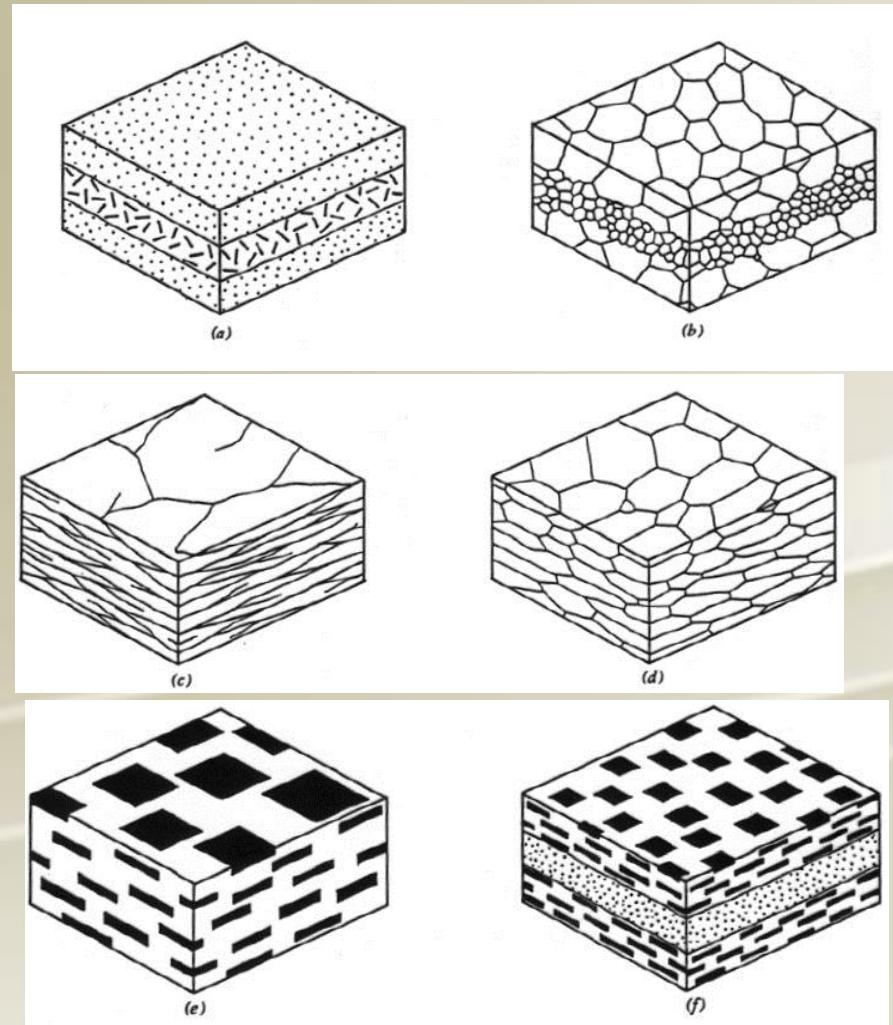
Original one quartz grain: now lattice orientations are different in patches: Subgrains



CPL with a Gypsum plate inserted
Passchier and Trouw (2006)

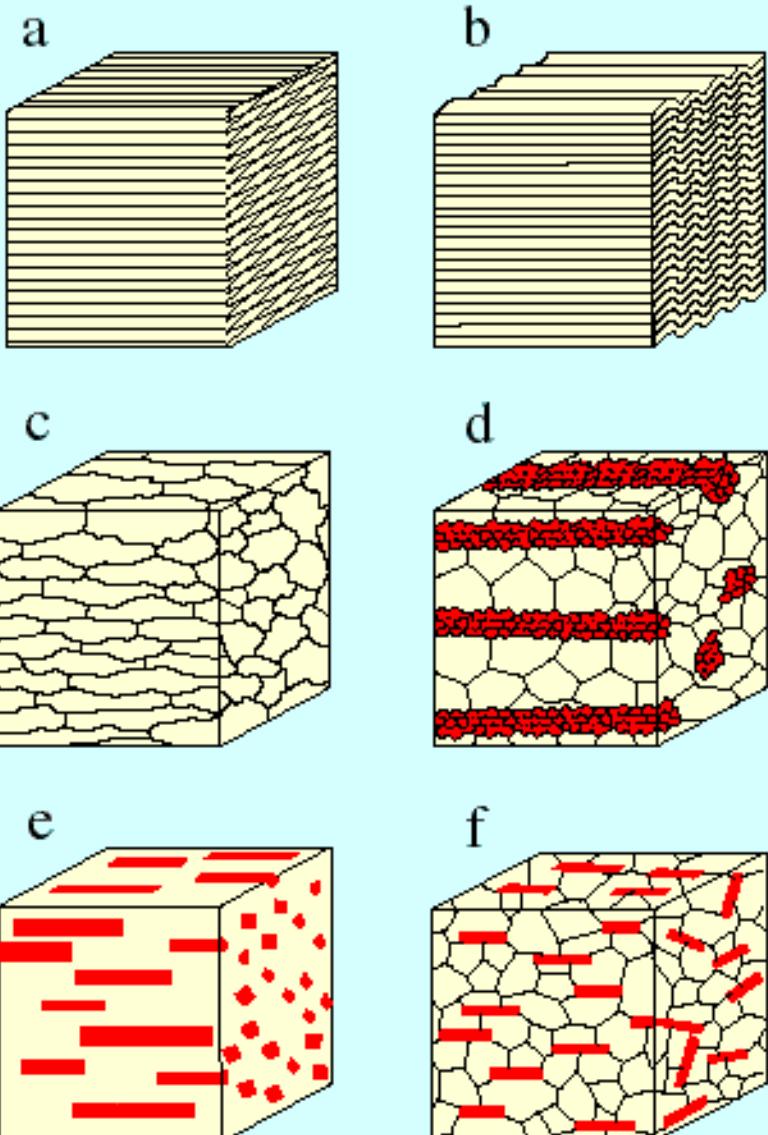
Foliations

- **Foliation can be defined by:**
- 1. Composition
(compositional layering)
- 2. Grain size/textured variation
- 3. Closely-spaced fractures
- 4. Shape of mineral grains,
clasts, pebbles etc.
- 5. Alignment of platy minerals
(e.g., mica)
- 6. A combination of above



Lineations

Intersection lineation
Fold axis
Elongated minerals/mineral aggregates/clasts
Striation



Foliation or Cleavage

If a foliated rock tends to break apart (*cleave*) along the foliation, the foliation is often called a cleavage.

Some foliations such as compositional banding in metamorphic rocks do not cleave along the foliation easily.

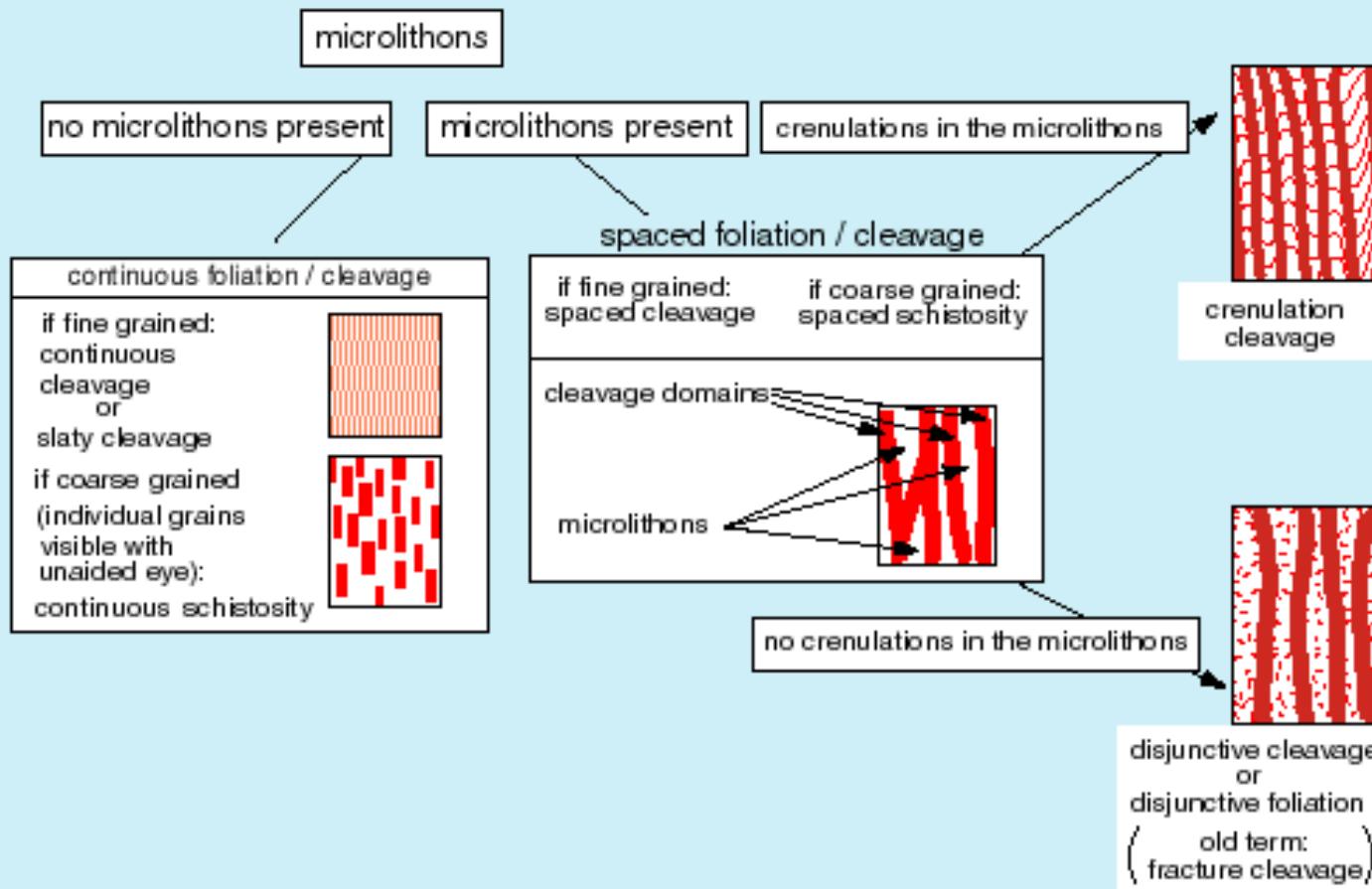
Foliations associated with folds

Axial plane foliations

- slaty cleavage (in slates)
- schistosity
- crenulation cleavage
 - microlithon
 - cleavage domain
- differentiated layering
- transposition foliation

Morphological classification of foliations

Morphological classification of foliations (using an optical microscope)



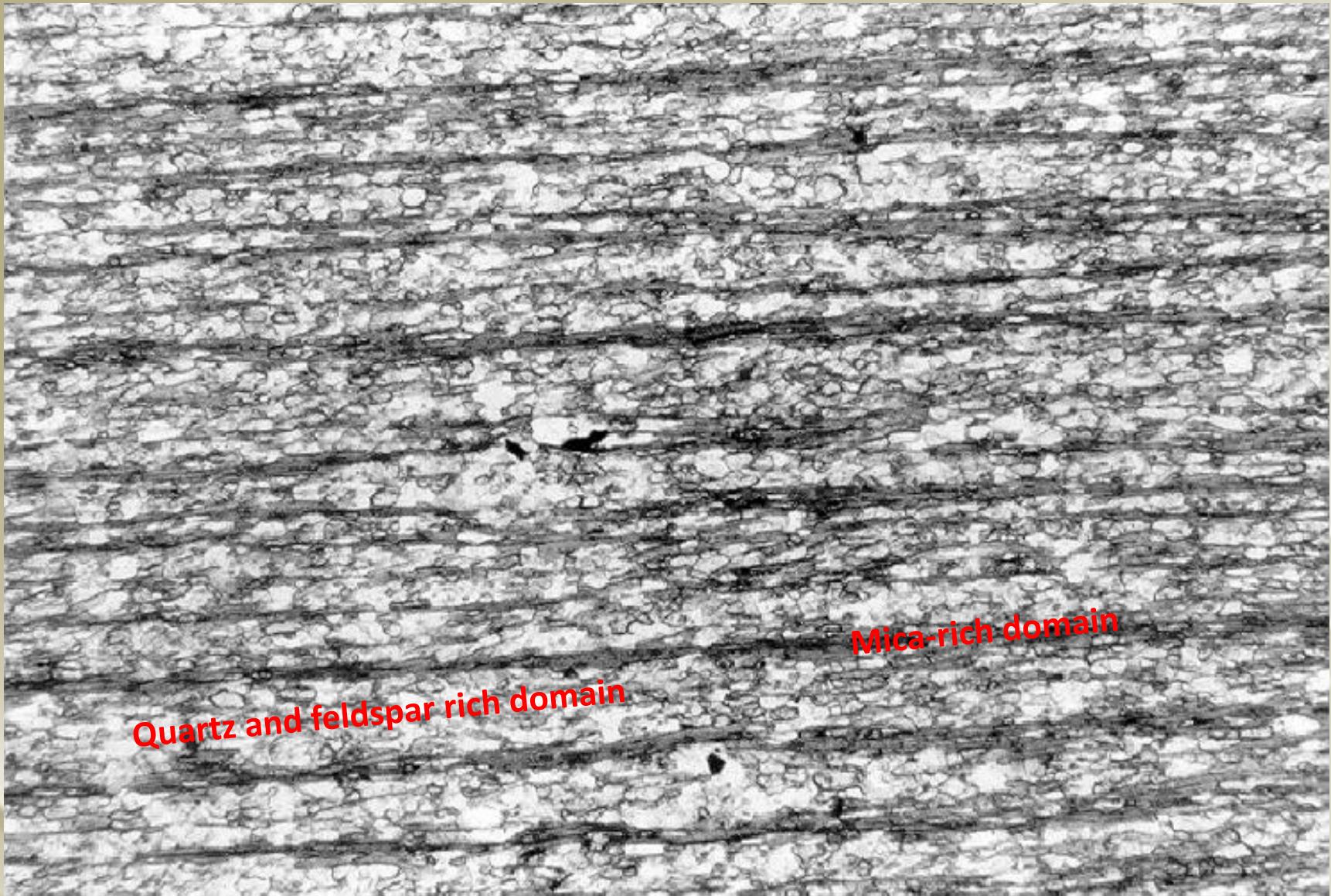
Passchier and Trouw (2006)

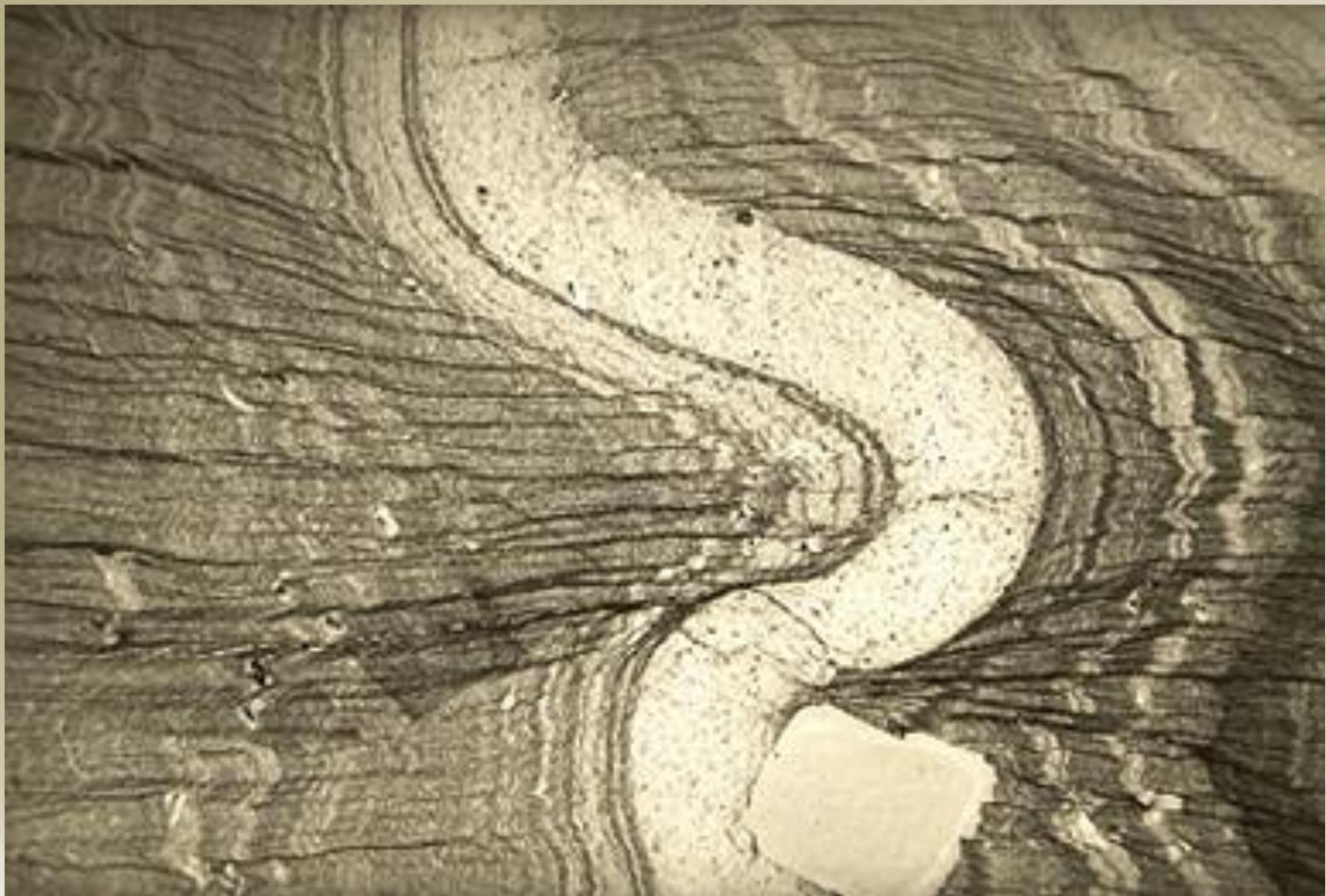
According to the classification,
which one is this foliation?



Passchier and Trouw (2006)

What foliation is this?



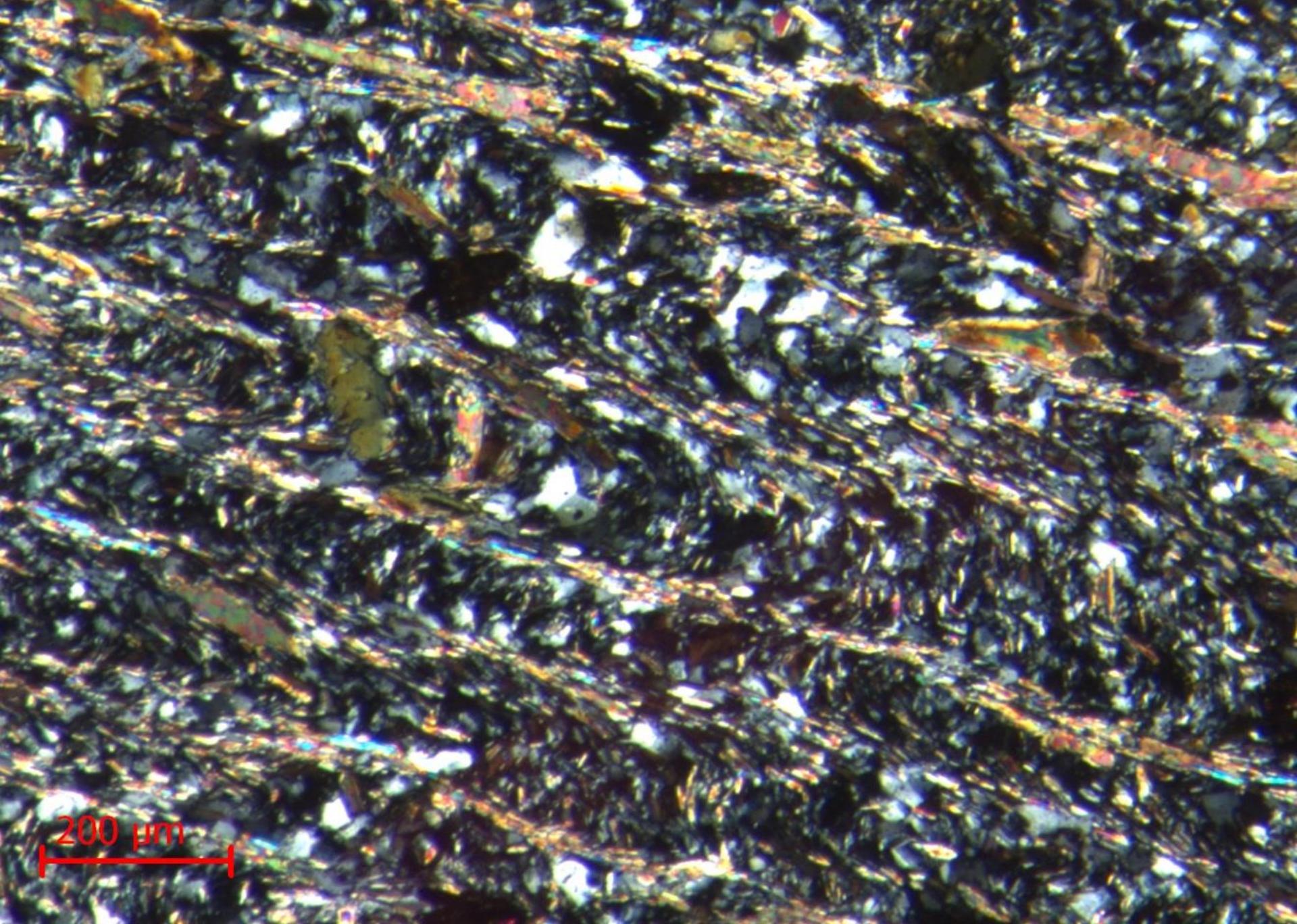


From a textbook

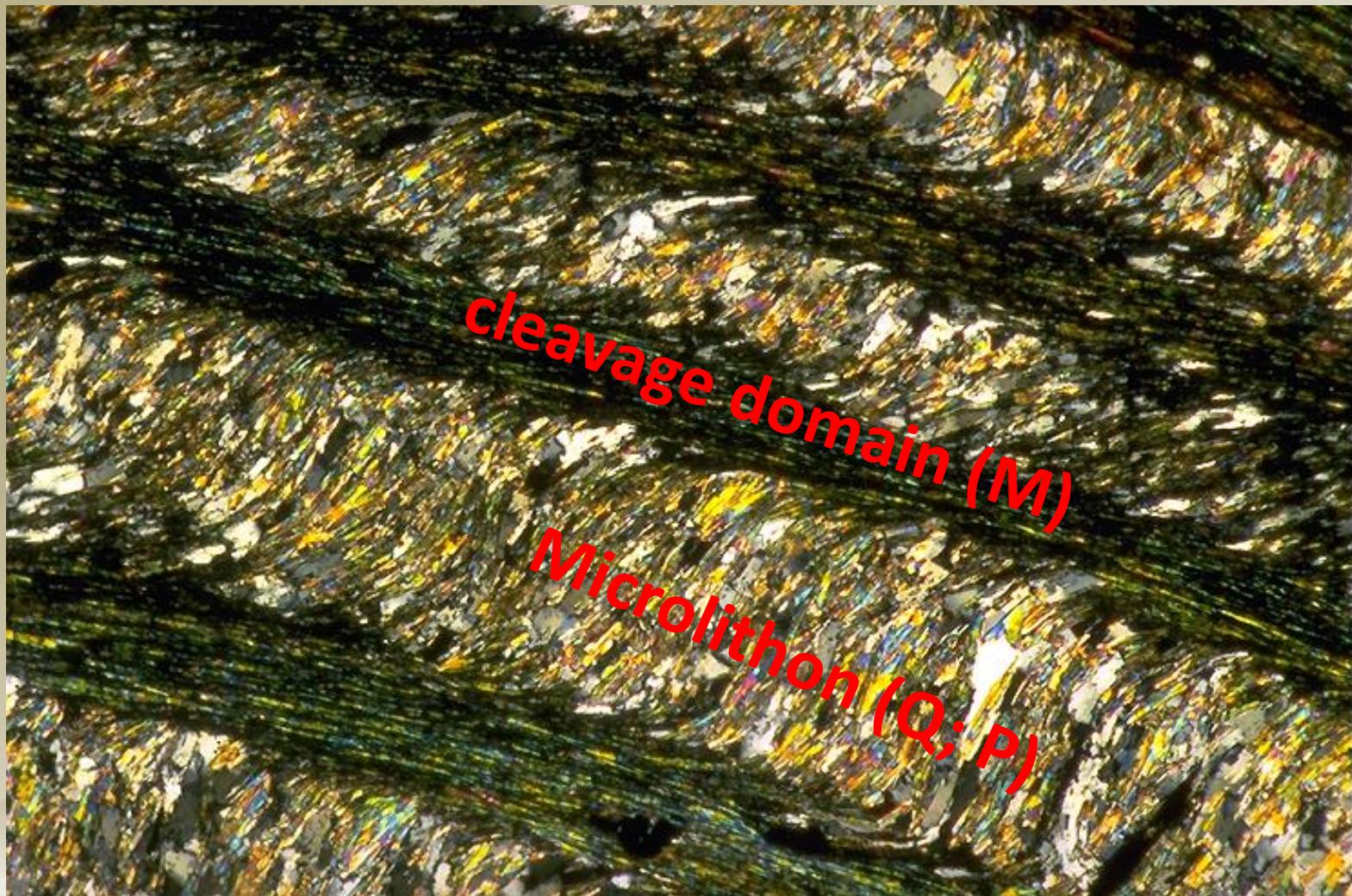
Dark: Oxides and some platy minerals; insoluble residule; Solution seam

Bright: Rich in quartz

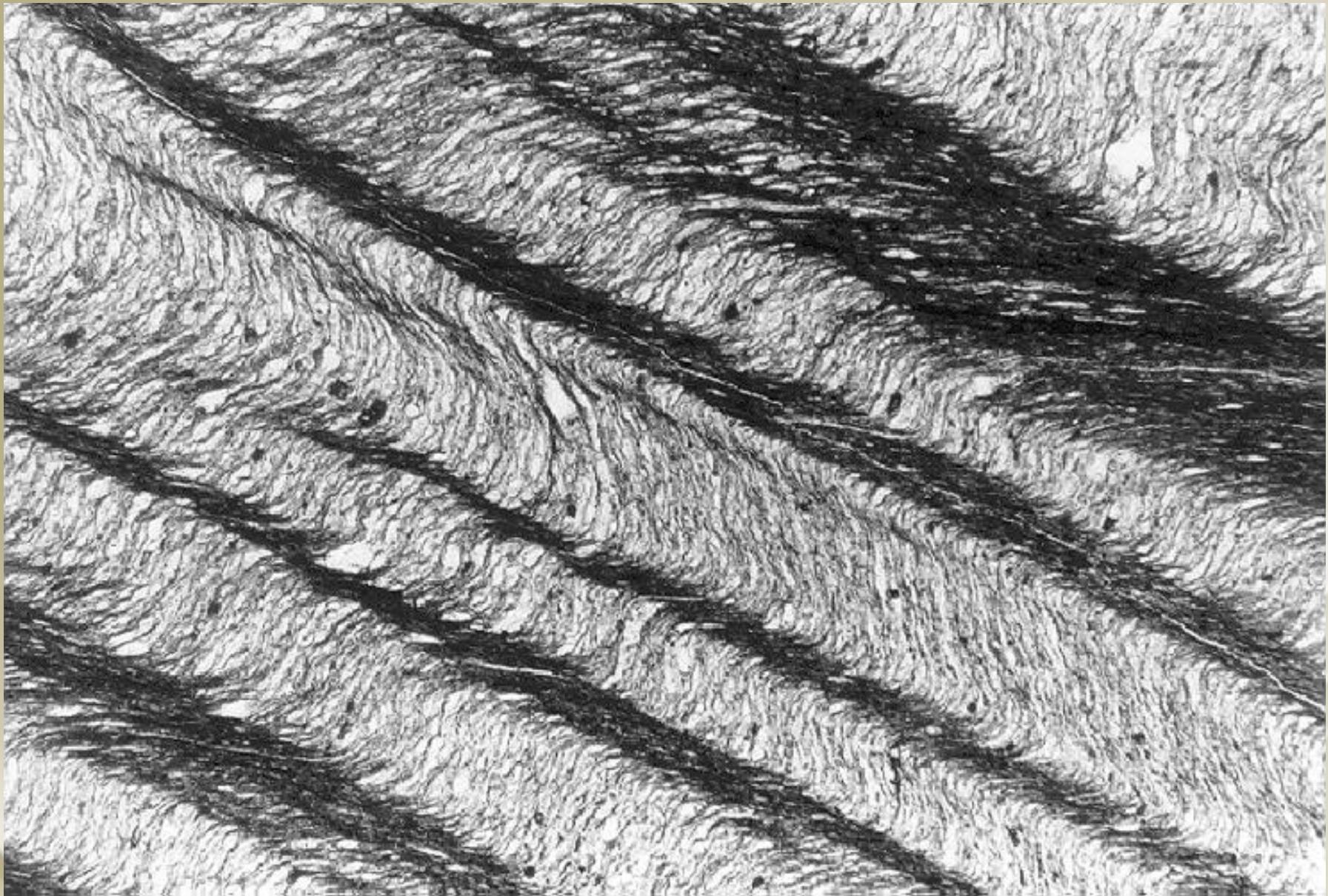




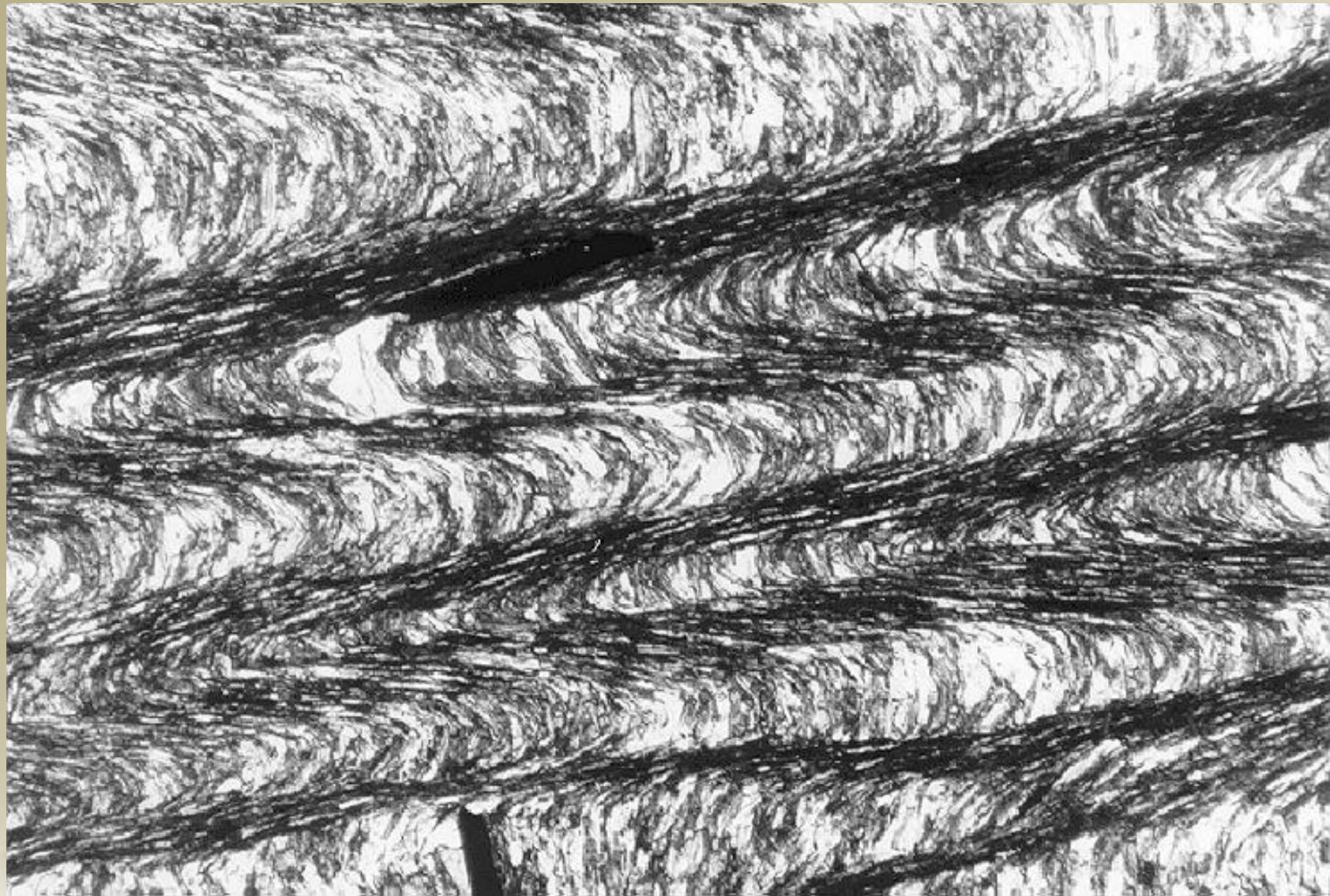
200 μm



Passchier and Trouw (2006)

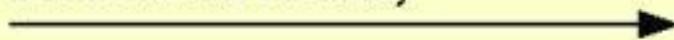


Passchier and Trouw (2006)

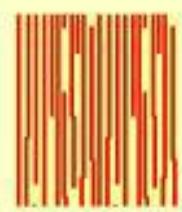
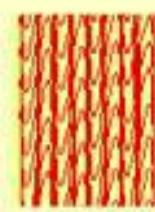
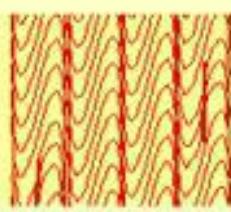
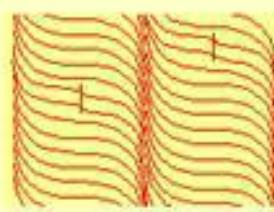
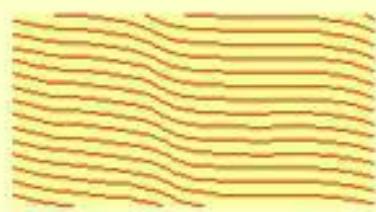


Passchier and Trouw (2006)

Deformation intensity



a



T
↓

b

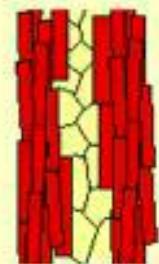
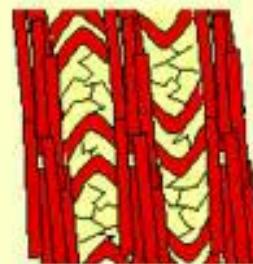
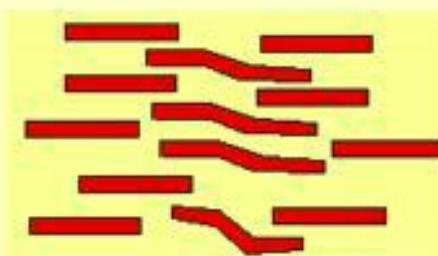
1

2

3

4

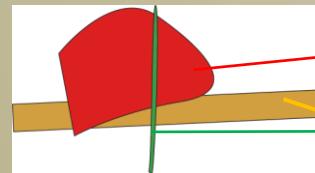
5



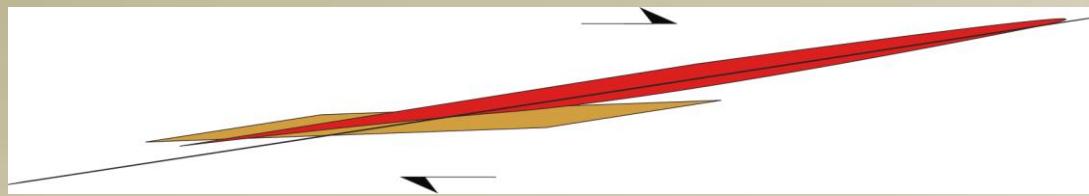
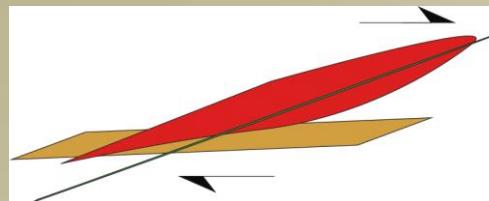




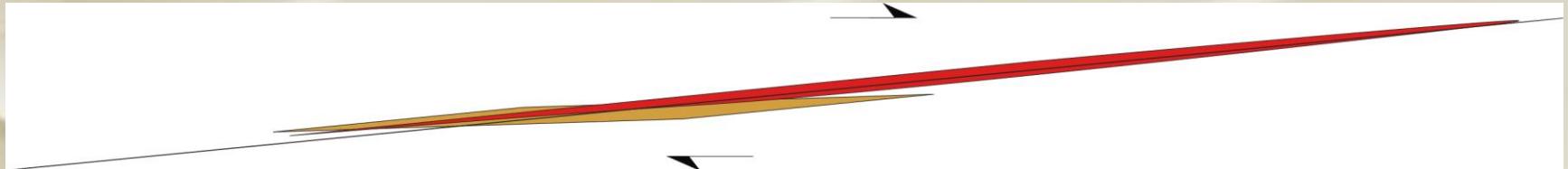




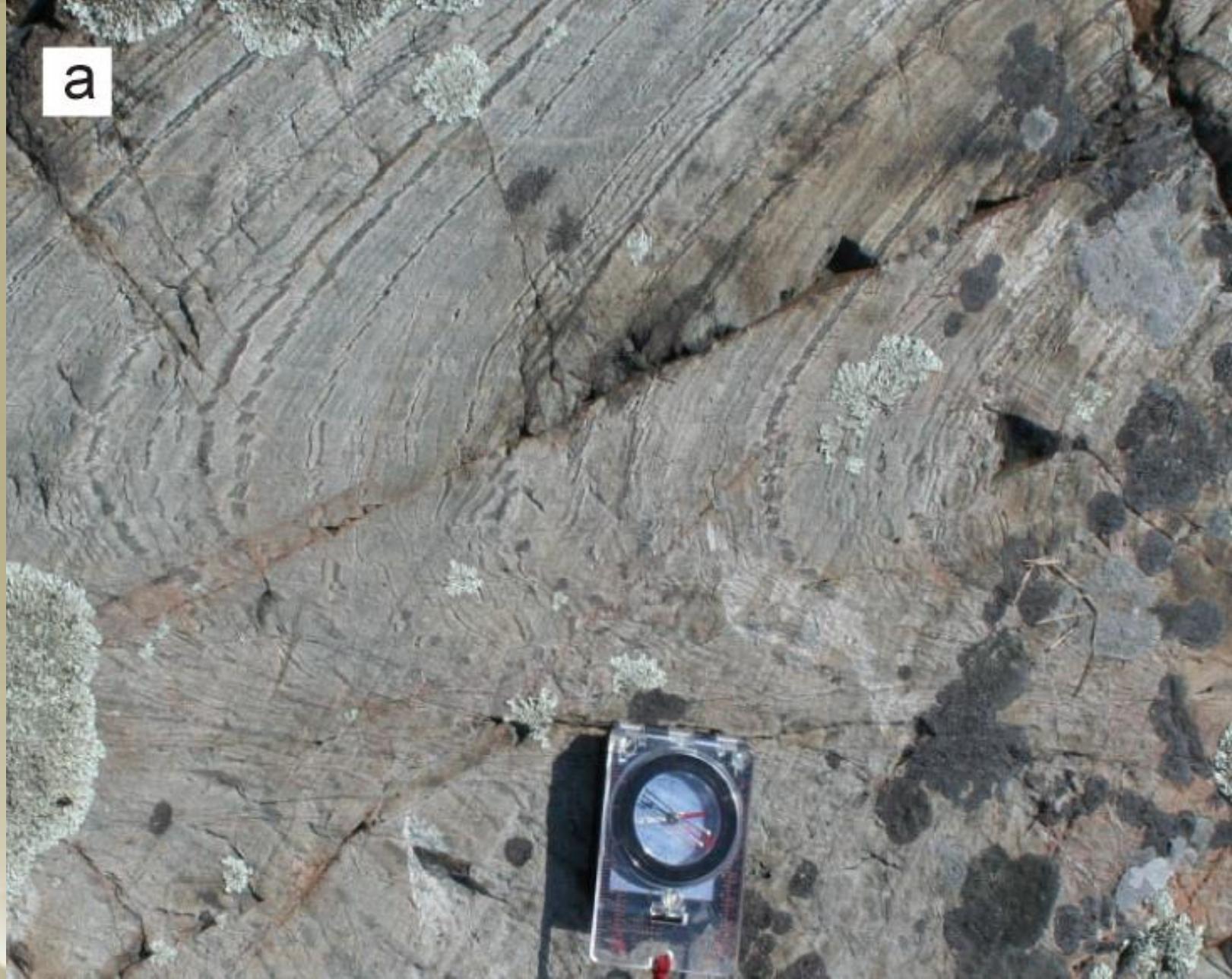
• Pluton
• Dike
• bed



Stretched into
lenticular shape in 3D;
Long axis rotated to be
horizontal

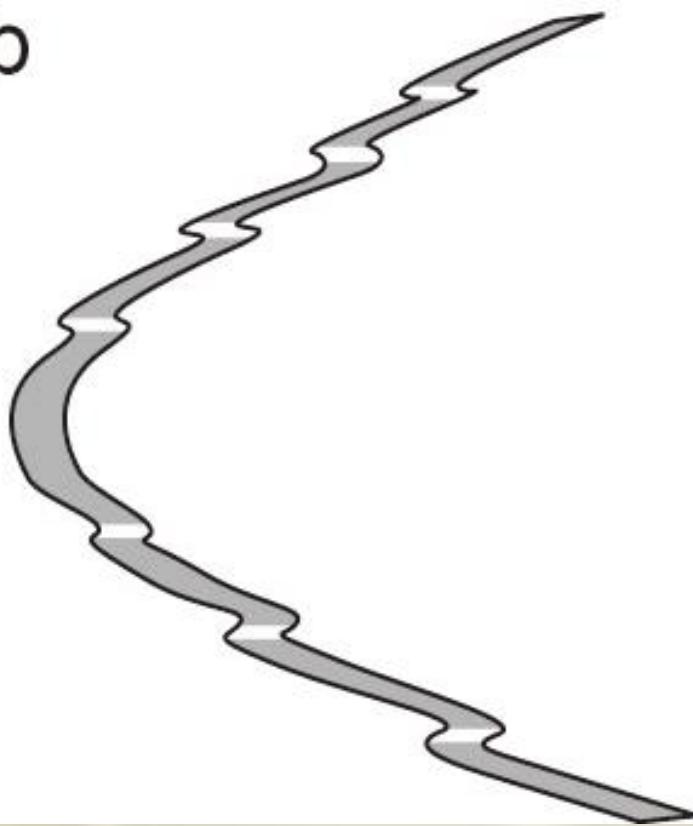


a

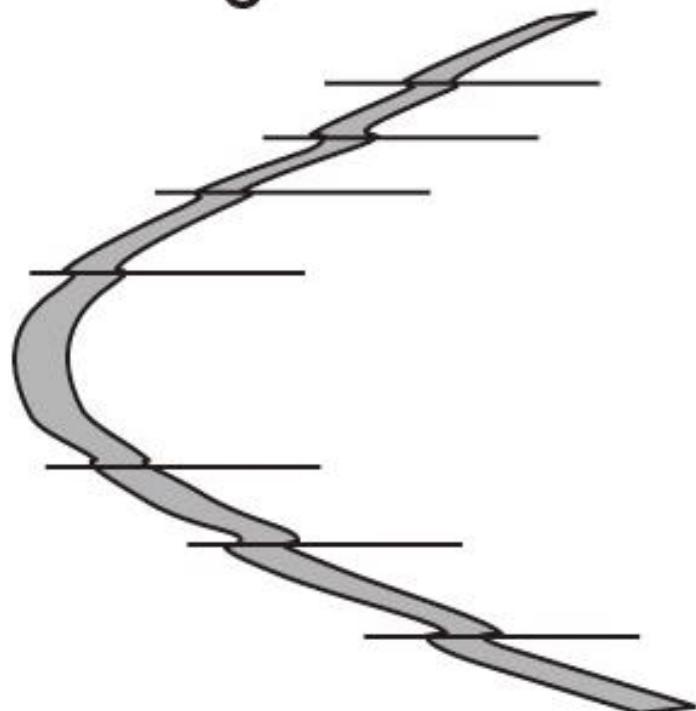


What is the dominant mechanism for the foliation?

b

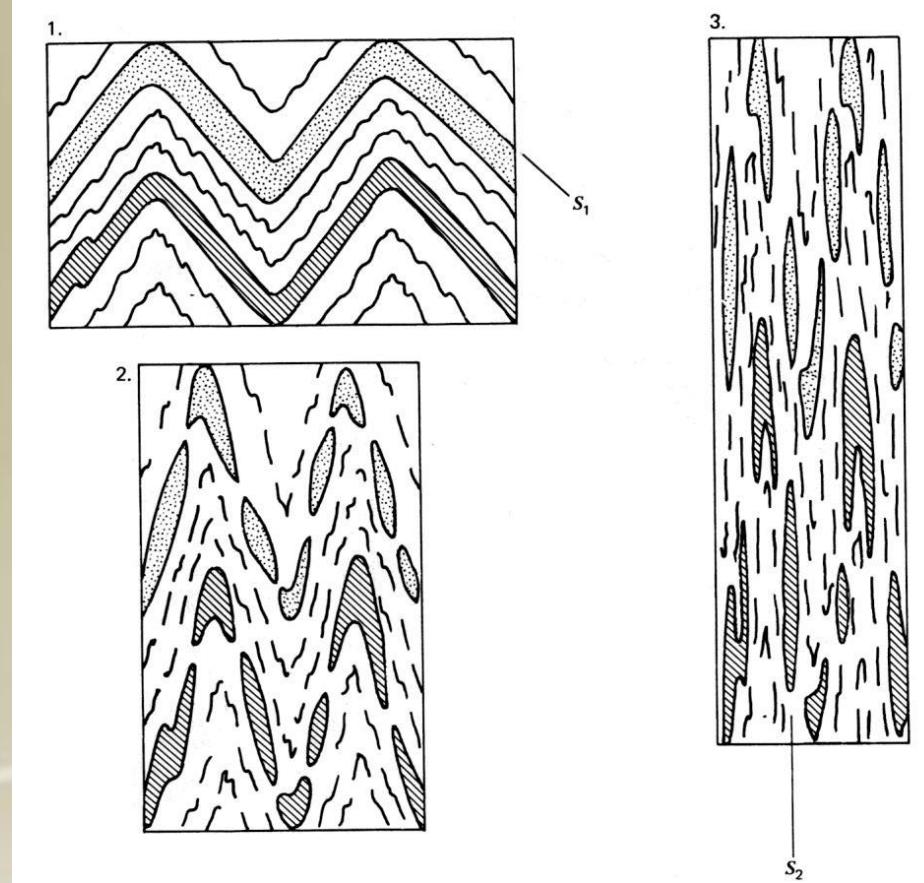
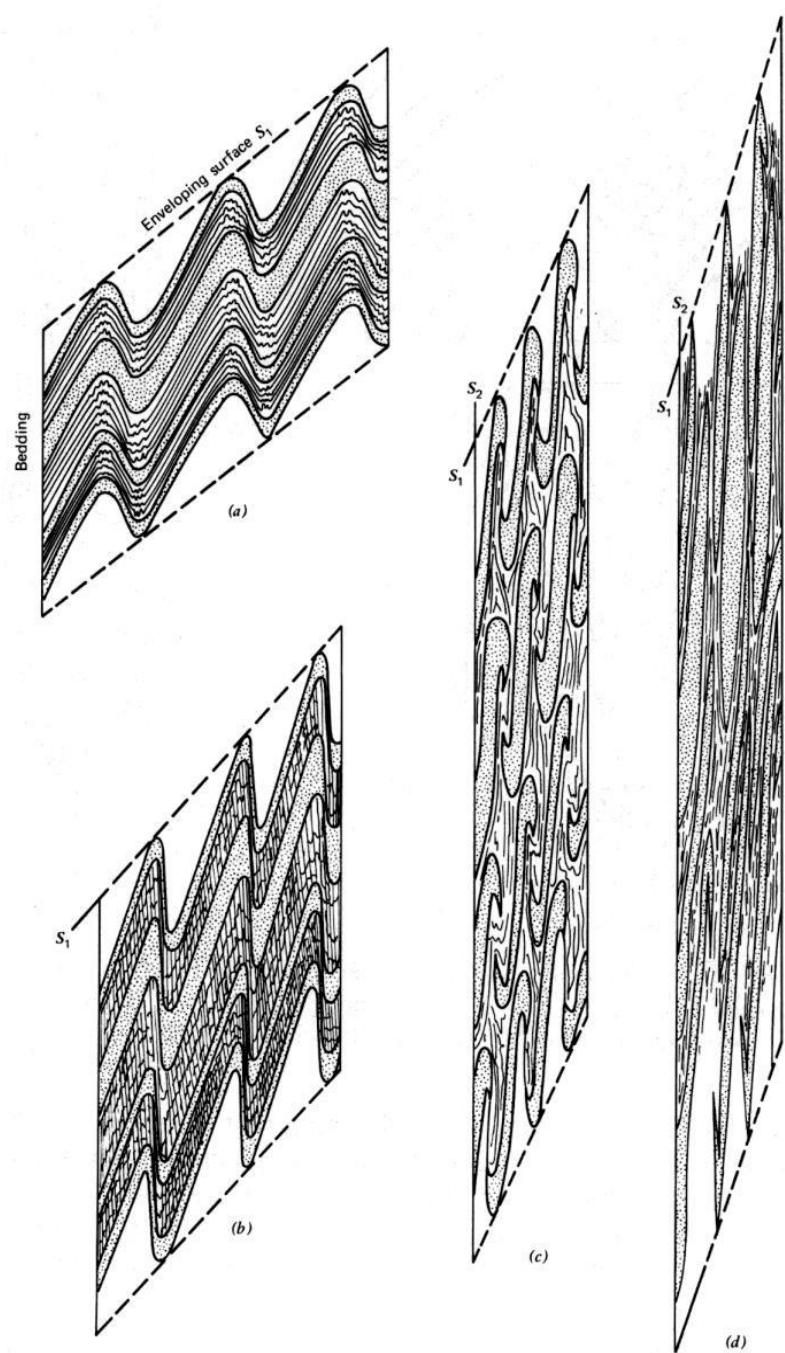


c



Deformed minerals are more soluble than undeformed ones.







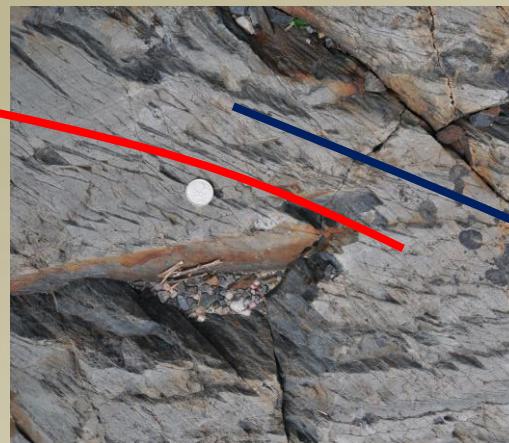
Sharpie

CD/DVD MARKER

FINE/ULTRA FINE

(AP)

Bedding and foliation relationship



Which is likely to be the bedding geometry?

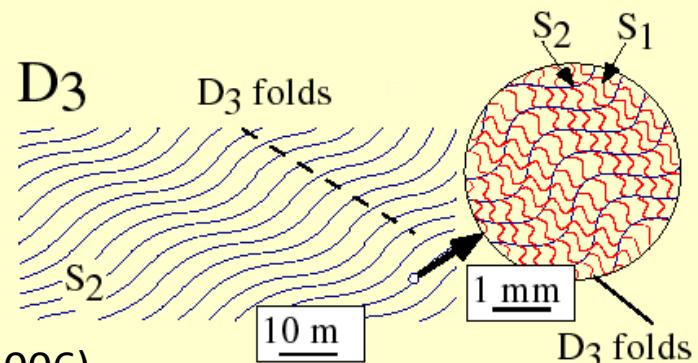
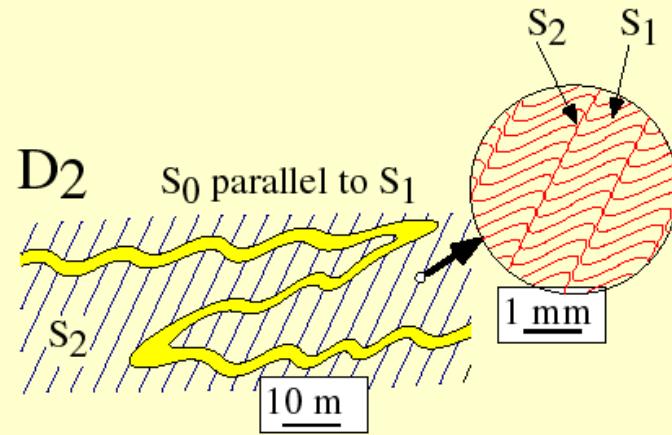
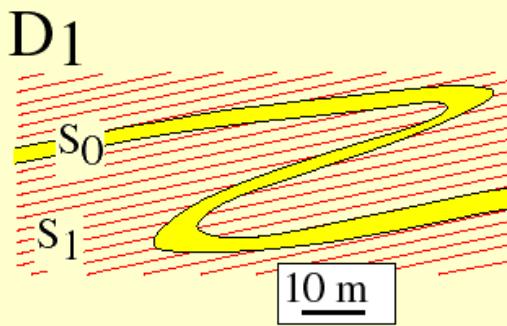
Bedding and foliation relationship





Which is likely to be the bedding geometry?

Schematic presentation of a comma sequence of foliation development

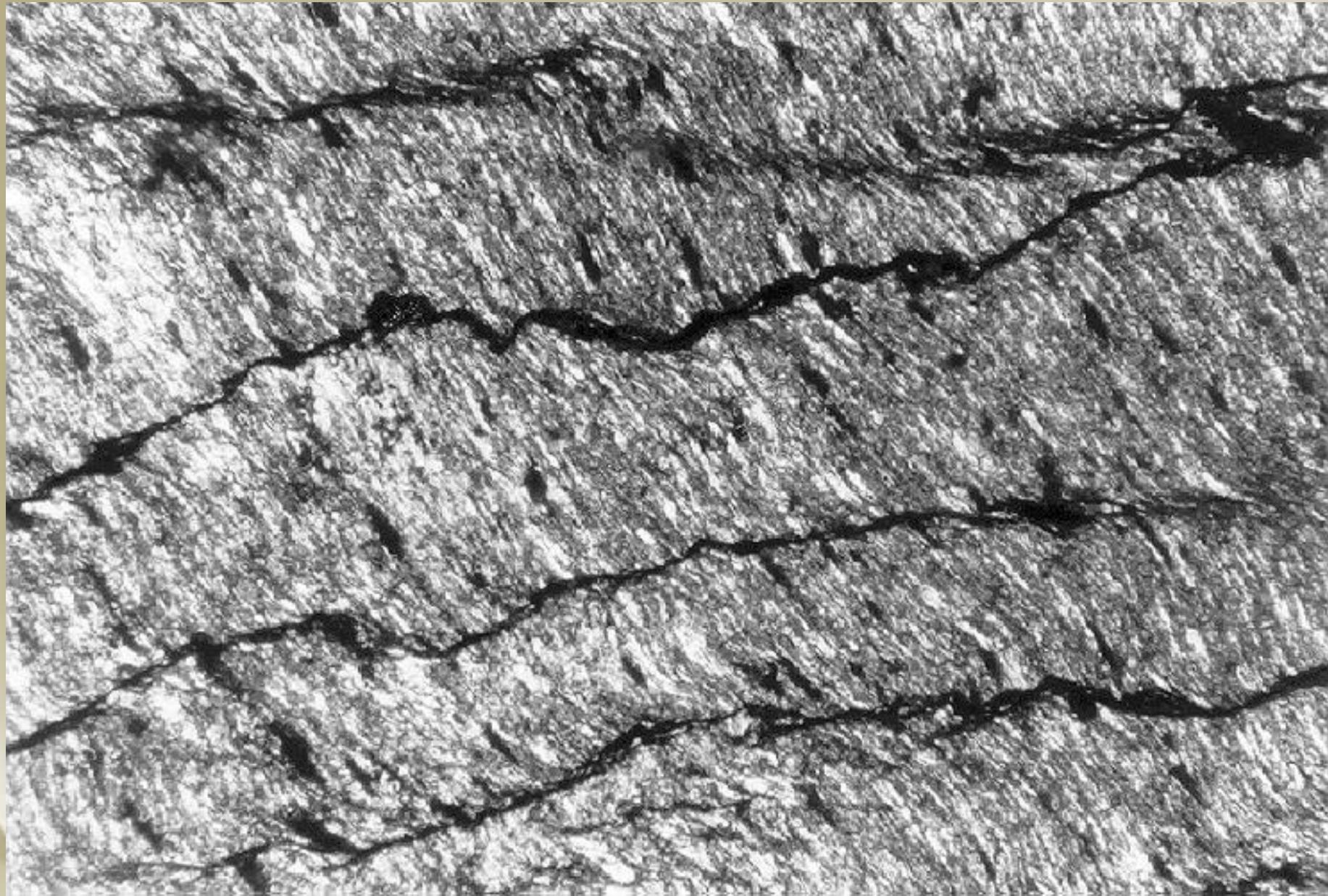


Passchier and Trouw (2006)

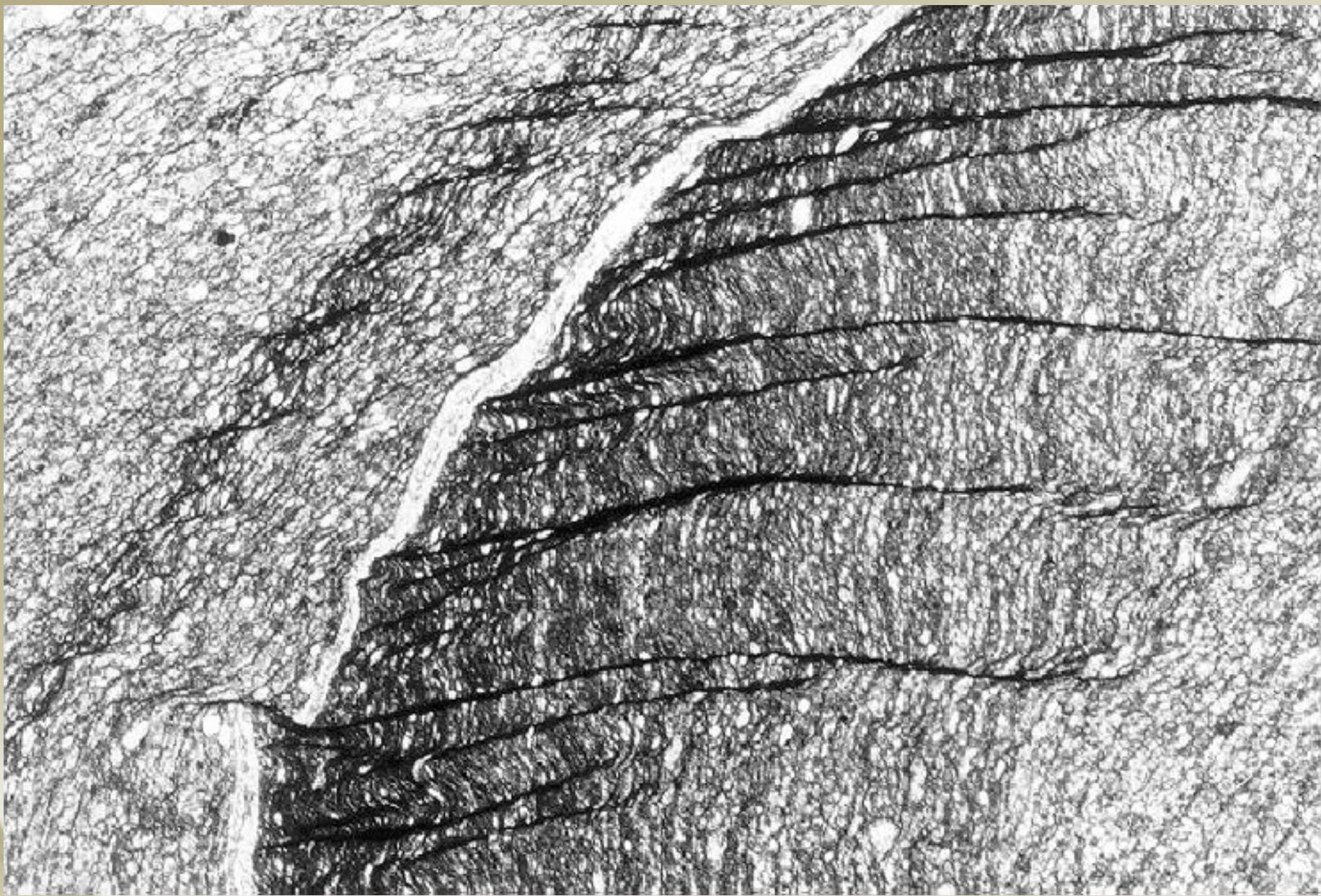


Foliation? Generation? Lineation? Defined by?





Passchier and Trouw (2006)

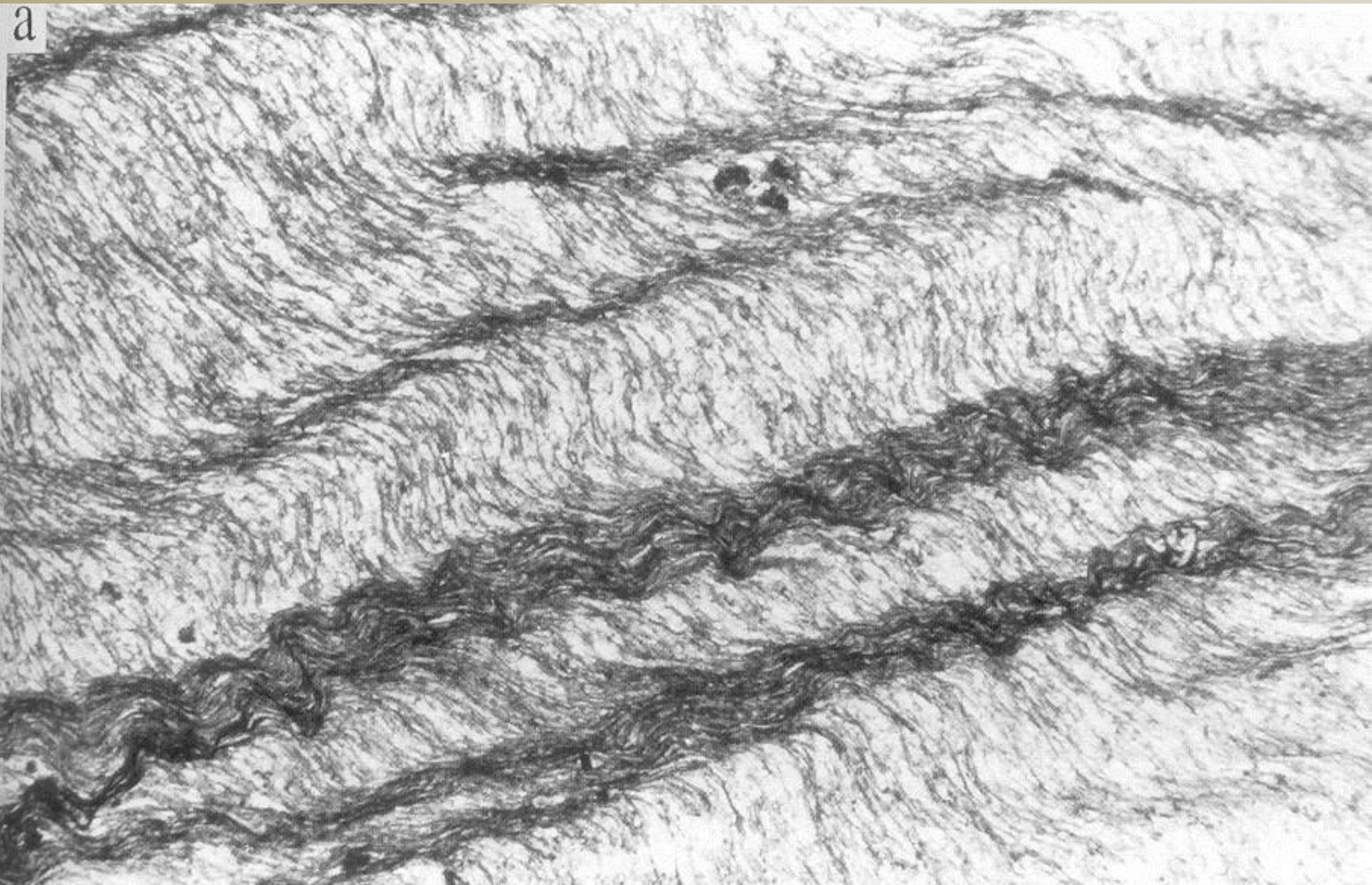


Passchier and Trouw (2006)



Trouw et al. (2010)

a



Passchier and Trouw (2006)

Multi-generations of crenulation cleavage, FOV (Field of view) =4mm

Sequence of events leading to selective refolding of a second foliation

